

instruments and methods of observation; and in a Report which has been laid before Congress and printed he has embodied the main results of his journey. The establishments visited were the Observatories of Paris, Neuchâtel, Geneva, Vienna, Berlin, Potsdam, Leyden, and Strasburg, and the workshop of Messrs. Repsold at Hamburg. Prof. Newcomb acknowledges the cordial reception he met with from the directors and astronomers of the various observatories, and the facilities everywhere afforded him for the execution of his mission. Most interest attached to the great refractor constructed for the Observatory at Vienna by Howard Grubb of Dublin, which was completed in 1881, but, owing to various delays, had hardly been brought into active operation at the time of Prof. Newcomb's visit in April 1883. Nevertheless he was able to compare it in several respects with the great Washington telescope, which is of only one inch less aperture. He considers that "as a piece of mechanical engineering it reflects great credit upon its designer and constructor." The chief drawback he remarked, the reasons for which were not evident either to him or to Dr. Weiss, the Director of the Observatory, consisted in the failure of the friction-rollers for easing the motion in declination; this motion was found much more difficult than in the case of the Washington telescope. Prof. Newcomb also points to the absence of any rough setting either in right ascension or declination, and the impossibility of seeing the pointing in declination except when the observer was at the eyepiece. With regard to the objective he considers, from such observations as he was able to make, that, "if any defects exist, they are so minute as not to interfere in any important degree with the finest performance of the instrument," and its proper figuring is rightly considered the most difficult task in the construction of a large telescope. In the workshops of Messrs. Repsold at Hamburg Prof. Newcomb had the advantage of meeting M. Otto Struve, and discussing with him the arrangements for mounting the 30-inch refractor intended for the Imperial Observatory at Pulkowa, the most striking feature in which is the absence of friction-rollers from the declination axis; he describes the system of wheelwork destined to obviate the difficulty of turning so large an instrument either by hand or a rope attached to the two ends of the axis, as at Washington and Vienna, owing to the amount of the friction. The eyepiece micrometers, as now constructed by the Repsolds, are commended for their rapid and convenient use. Amongst his general practical conclusions Prof. Newcomb expresses the opinion that in the mounting of instruments of the larger size, in order to secure necessary stiffness with the least weight, the axes should be hollow. He does not consider that it is worth while to attach friction-rollers to the declination axis, unless further experiment should show that they can be rendered more effective than in the Vienna equatorial. The old system of attaching a single finder to that side of the telescope which is opposite the declination axis, he remarks, is insufficient in the case of a large instrument, owing to the necessity of setting the opening in the dome not only to the telescope but to the finder, and suggests the desirability of adopting the plan in the Vienna instrument, which has two finders, the one above and the other below the telescope when in the meridian—a plan obviating all difficulty. The Report further explains the principle of the equatorial *coudé*, or elbow-shaped equatorial, of the Paris Observatory. The Strasburg meridian-circle, "commonly considered to embody the latest conceptions in astronomical mechanics," is noticed in some detail; Prof. Newcomb thinks a degree of stability has been secured in it which has never before been reached, and he was at much pains to obtain data for comparing the instrument with the meridian-circle at Washington; its general design he describes as similar to that of the great meridian-circle at Harvard College Observatory, which was constructed by Troughton and Simms of London. The reader must be referred to the Report for other particulars bearing upon meridian instruments.

THE ASPECT OF URANUS.—In a note communicated to the Paris Academy of Sciences on June 9, MM. Henry state that, observing on very fine nights with the 15-inch refractor, they have satisfied themselves of the existence of two gray belts, straight and parallel, and placed almost symmetrically with respect to the centre of the disk of Uranus, and that, by measures of their direction, they have found an inclination of about 41° to the direction of the orbits of the satellites; they assume that the planet's equator is in the direction of the belts. Astronomers will probably look for confirmation of such an anomaly to our larger instruments.

THE CONTINUITY OF THE PROTOPLASM THROUGH THE WALLS OF VEGETABLE CELLS

AMONG the numerous generalisations of modern botany there are perhaps few that promise to have more important consequences than the recent statements to the effect that the protoplasmic contents of the cells of plants are not entirely shut off from one another by the cell-walls, but that arrangements exist of such a kind that more or less delicate strands of protoplasm pass through from one cell to another, piercing the cell-walls either at numerous points at certain thinner spots, or simply here and there.

Th. Hartig in 1837 distinguished certain constituents of the bast of phanerogams which we now know as sieve-tubes. Investigated later by the same observer and by Mohl, Nägeli, Sachs, and Hanstein, the question as to whether the septa between the cylindrical constituents of these tubes are really perforated, or simply studded with thin pits, was set at rest by the demonstration that strands or cords of protoplasmic substance pass through definite pores or passages in the septa or cell-walls. This discovery then became common property, abundantly confirmed, and is now practically demonstrated by students in every properly conducted botanical laboratory: it remained somewhat isolated for many years, however.

In 1880 the botanical world was startled by Tangl's discovery that the cells of the endosperm of certain seeds (*Strychnos*, *Areca*, &c.) present a similar feature—that delicate filaments of protoplasm traverse the cell-walls through fine perforations, and so place the protoplasmic contents of the cells in direct continuity one with another.

In 1882 Gardiner showed that a similar continuity of the protoplasm exists between the cells of the motile organs of certain sensitive plants, and there can be no doubt that the communication thus established through the cell-walls is instrumental in causing the propagation from cell to cell of the stimulus which induces the movement. It thus becomes established that the cell-walls of plants can no longer be regarded as entirely separating off the contents of one cell from those of another; but that, in many cases at any rate, the idea of the individuality of the vegetable cell becomes as difficult to maintain as did that of animal cells after the first struggles which resulted in the overthrow of the old cell theory.

Since 1882, Gardiner has succeeded in extending his results, and has shown that the cells of numerous other parts of plants are in continuity in the same manner, by strands of protoplasm passing through the cell-walls. These researches are, moreover, confirmed by Russow for certain cells of the parenchyma of bast and medullary rays; and there seems little need of hesitation to accept generally the view that the cells of plants are not closed sacs as was formerly believed, but are provided with passages through their walls, through which fine filaments of protoplasm communicate. Such at least results from the observations so far, and especially those of Gardiner, on the endosperms of a large series of plants. It may now be stated, however, that this is not the only evidence to be quoted in support of the above generalisation. In addition to the observations of Nägeli, Pringsheim, and others, pointing out that the protoplasm frequently adheres to the cell-walls so closely at certain places that it may be pulled out into strands, or even break away, leaving portions on the walls, Gardiner has also made observations which confirm this, and which strongly favour the view that the protoplasmic strands are held fast at the points where they traverse the cell-walls. Bower has also observed similar phenomena in the withdrawal of the peripheral protoplasm in plasmolysis.

Moreover, it has been pointed out that in the case of cells with very thick walls, the thin pits are normally found to meet on opposite sides; the same is the case with the radiating strands in *Volvox*, and where two opposite strands reach the common cell-wall at different angles, they nevertheless meet at a point.

So far, however, there is no evidence to show whether the continuity of the protoplasmic strands is maintained from the earliest stages, or is established later. This, however, is a very important question in connection with this subject, since the answer to it will materially affect our views as to the nature of the cell. If the cell-walls produced in vegetative division are not complete septa, but membranes filling up the interstices between continuous strands of protoplasm, then the continuity of the protoplasm through the wall of vegetable cells is simply to be regarded as an expression of the fact that the entire plant or

organ is practically one whole—one mass of protoplasm cut up into chambers which communicate with one another, and bounded by a membrane on the exterior. If, on the other hand, the communications between the protoplasm of neighbouring cells are only established after a complete septum has been formed, then it may or may not be that the above view holds, —so far as the continuity of the protoplasm of mature cells is concerned, it affords no conclusive proof against the very generally accepted idea that the plant consists of cell units aggregated into colonies, tissues, &c.

Turning for a moment to certain investigations which throw light on this matter from totally different directions, it will be seen that there is much to be said for the view lately stated by Sachs, and first hinted at by Hofmeister, that a much closer relation of cell to cell exists than can be well explained by the theory that a plant is a sort of cell republic, consisting of aggregated cell units.

Strasburger's well-known investigations on the process of cell division have led to the remarkable and startling result that the septum or partition-wall, formed when a cell divides, is in general a solid membrane built up by the aggregation of certain particles (microsomes) which become arranged into a plate (the cell-plate) at the equator of the dividing mass of protoplasm. These microsomes are conducted to this equator, and there mobilised by certain delicate fibrillæ in the protoplasm; these fibrillæ form the well-known spindle-like figure, and are continuous across the equator. If the microsomes travel along the fibrillæ from either side, and are fitted together between them, it seems difficult to doubt that the continuity of the protoplasm observed later simply depends upon the persistence of this primitive continuity, and such appears to be the case.

The proof that the primitively continuous fibrillæ remain continuous throughout does not yet exist however; and although it is so likely, it cannot be forgotten that protoplasm possesses a marvellous power of boring through and dissolving even adult cell-walls, as is evident in the exit of zoospores or the entrance of parasites through cell-walls, the formation of pollen-grains, &c.

But we have not yet exhausted the evidence for the view that the continuity of the protoplasm through the cell-walls of fully developed organs exists from the first.

The investigations of Strasburger, Schmitz, and others, on the protoplasm and nucleus of vegetable cells, have yielded the results that, in the first place, many cells believed to be devoid of nuclei really possess these structures, and often in enormous numbers; and, secondly, that many cases of division occur where a delicate cell-wall is formed in the equatorial plane between the two dividing nuclei, but only to disappear later. In many other cases no recognisable septum is formed at all. The internodes of *Chara* and the zoosporangia of *Achlya* may be cited as examples. In *Vaucheria*, *Caulerpa*, &c., again, we have plants each of which is practically a single cell with numerous nuclei: these nuclei divide as the cell grows, but no cell-walls are formed—the plant remains "unicellular."

If in such cases a septum were formed each time a nucleus divides, the protoplasm of the *Vaucheria*, *Caulerpa*, &c., would become divided up into cells; and if the septum in each division were incomplete only in so far that it allowed the fibrillæ of protoplasm which carry and arrange the microsomes to remain continuous through it, we should have essentially the condition of things demonstrated by Hanstein, Tangl, and especially by Gardiner.

But it would in such a case be imperative to express the facts in accordance with the primitive state of affairs—the protoplasm of the hypothetical plant would be cut up into compartments or cells, communicating throughout. Now it is just this view which Sachs has lately brought forward so clearly and ably. A multicellular plant does not grow and become complex because it consists of numerous aggregated cells which increase and divide; but it becomes multicellular because it grows larger, and partition walls are placed in the mass partly for mechanical purposes, partly to insure physiological distribution of labour.

It is impossible, Sachs thinks, to hold the view that *Vaucheria*, *Caulerpa*, and such plants have arisen by the degradation of ancestors which formed cell-walls. It is also suggestive that the nuclei in such "unicellular" plants are more closely packed at the growing apex of the vesicle; for we may thus understand how the growing point of an organ with a single large apical cell only differs in degree from one with numerous small apical cells.

The consideration of all these matters leads to the conviction that the cell-theory so long taught may have to be modified even

more than it has been during the last ten or twelve years; and that once more we are being driven back to that centre of all biological phenomena—the properties of protoplasm, multiple and various in degree and in kind as they are.

In conclusion, we cannot omit drawing attention to the improved and refined methods employed by the careful and skilled botanists of the younger school; and it is to be hoped that those who pass over the ground again will be at least equally well equipped. It is not only reagents that are necessary in such matters—critical power is indispensable as well as pure chemicals, as any one may convince himself by the study of the recent memoirs referred to, including the careful papers from Gardiner's hands. One more point may well be insisted upon here: the exhaustive study of a series of facts invariably brings them at length into relation with other facts, and where neither series is alone sufficient to base a scientific induction upon, converging groups of observations may result in the establishment of very important generalisations, leading to the recognition of still larger consequences. There can be no question of the intrinsic value of the observations on the continuity of protoplasm, apart from the information they give in connection with physiological matters; but it is certain that they gain immensely in scientific importance when looked at in the light afforded by recent discoveries as to the behaviour of the nucleus and protoplasm in cell division.

NATIONAL WORK AND HEALTH

THE work of the International Juries was formally inaugurated at the Health Exhibition on Tuesday by H.R.H. the Prince of Wales. The principal address was given by Sir James Paget, who chose as his subject "The Relation between National Health and Work," especially as it may be shown in a few of the many examples of the quantity of work which is lost to the nation either through sickness or through deaths occurring before the close of what may fairly be reckoned as the working time of life.

Sir James Paget went on to say:—I think it may be made clear that this loss is so great that the consideration of it should add largely to the motives by which all people may be urged to the remedy of whatever unwholesome conditions they may live in. It is a subject which is often in the minds of the real students of the public health, but the public itself is far too little occupied with it.

In view of the national health and welfare, the pattern healthy man is one who lives long and vigorously; who in every part of his life, wherever and whatever it may be, does the largest amount of the best work that he can, and, when he dies, leaves healthy offspring. And we may regard that as the healthiest nation which produces, for the longest time and in proportion to its population, the largest number of such men as this, and which, in proportion to its natural and accumulated resources, can show the largest amount and greatest variety of good work.

Here let me insert, as an interpretation clause, that in all this and what is to follow the word "man" means also "woman," and "he" also means "she"; and that when I speak of work I mean not only manual or other muscular work, but work of whatever kind that can be regarded as a healthy part of the whole economy of the national life. And I shall take it for granted that a large portion of all national welfare is dependent on the work which the population can constantly be doing; or, if I may so express it, that the greater part of the national wealth is the income from the work which is the outcome from the national health.

It is a common expression that we do not know the value of a thing till we have lost it; and this may be applied to the losses of work which are due to the losses of national health. There are very few cases in which these can be estimated with any appearance of accuracy; but I am helped to the best within our present reach by Mr. Sutton, the Actuary to the Registry of Friendly Societies. In his office are the returns, for many years past, of the sickness and mortality among the members of a very large number of these Societies; and, among other things, there is recorded the number of days on which each member, when "off work" on account of sickness, received money from his Society. Hence Mr. Sutton can estimate, and this he has been so good as to do for me, the average number of days' sickness and consequent loss of work among several hundred thousands of the workmen and others who are members of these Societies. From the entire mass of these returns, he deduces that the